

Space Weather Technical Forecast

Issued on Tuesday, 17 September 2024 at 01:26 Local

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: CME arrived at L1 at 16/2250UTC, Earth at 16/2329UTC. G1-G2 geomagnetic storms Likely. Ongoing Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured at GOES16 and 18 was Low, with occasional mid-ranking C-class x-ray flares observed, peaking with a C5.9 at 16/0125UTC from AR3824 in the southwestern quadrant. This was trumped at the literal eleventh hour by a C9.6 from AR3825 at 16/2356UTC.

There are up to eight sunspot regions on the disc, with AR3828 attaining a number as an Hsx group near the eastern limb in the period. The main changes in the period were seen in both of the most complex regions on the disc at present, a pair of Esi/Beta-Gammas. AR3825 in the southeast saw areal growth of its leading spots, although this was roughly matched by a decline in its trailers. This was the larger of the two main groups, and it is this spot that has a history of X-class activity. Also of note was AR3824 in the southwest, which saw proliferation of minor central spots followed by a spreading tendency. Remaining groups were either more simple magnetic dipoles or else apparently unipolar.

No Coronal Mass Ejections (CMEs) were in evidence in the period, Earth-bound or otherwise.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by ACE at L1, showed ongoing slightly elevated solar wind speeds, abruptly giving way to a CME at 16/2250UTC. This CME shock hit Earth at 16/2329UTC and resulted in a change in the BGS Hartland magnetometer H component of 35nT in the three minutes from 16/2329UTC.

The steady positive phi angle (away from the Sun) prior to this arrival may indicate connection to a positive coronal hole, perhaps CH69/+ in the southwest although the source is uncertain. This may be back-dated to onset around Saturday 14 September, with a slight increase in solar wind speed and decrease in solar wind density around this time.

The solar wind speed was erratic, mainly within the 400s of km/s and an average of 450km/s, but rising to near 550km/s after 16/2250UTC. The solar wind density was stable within single figures ppcc, with a slight uptick at the CME arrival time. The IMF was Slightly Elevated, rising mid-period to a high of 10nT, while the north-south component varied between +8 and -9nT. This changed to a high of 18nT and a north-south range between +9 and -13nT in the wake of the CME shock.

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The net result of the above solar wind measures was Active and later Quiet geomagnetic indices, with a provisional peak Kp of '4o' in the 12-15UTC interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 is slightly above normal background levels following the X4.5 flare on 14 September, with a very gradual decline from a peak near 4pfu, i.e. below the S1/Minor Storm threshold.

High energy electron flux (greater than 2MeV) observed by GOES16, generally varied on a diurnal cycle between Normal Background to High levels, peaking at 2240pfu at 16/1215UTC. The associated 24-hour fluence showed a generally flat trend, with 4.3e7 integrated pfu observed at 16/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast, with a Chance of M-class flares, most likely from AR3824 or AR3825. There is a Slight Chance of an isolated X-class flare from AR3825. No significant regions are expected to arrive or depart in the period and the risk is deemed roughly constant as a result.

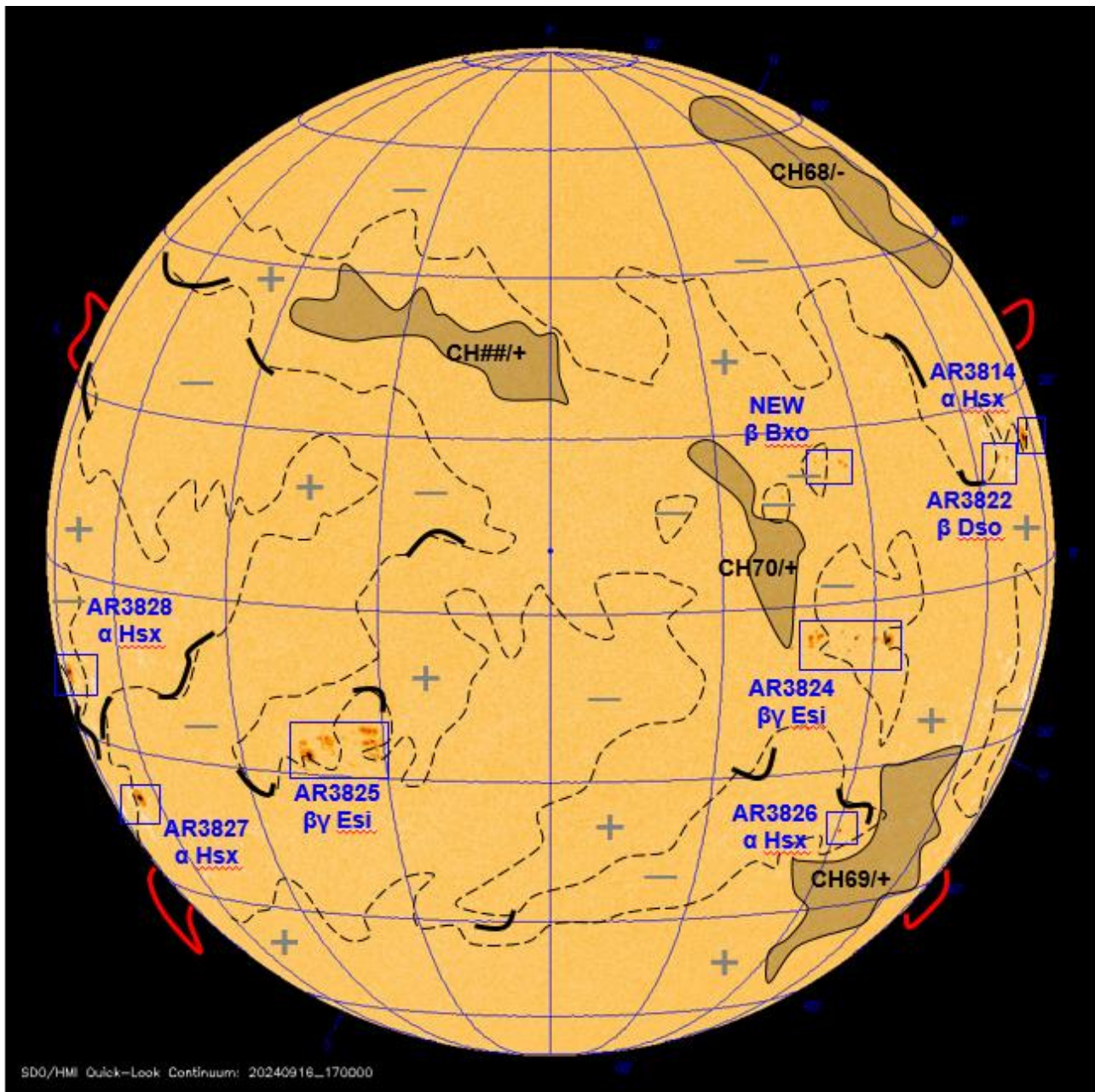
Solar Wind / Geomagnetic Activity: The main inbound CME from the X4.5-related CME on 14 September has now arrived (and the 13 September CME which it may have swept up). A now-moderated Likely G1-G2 is possible within day 1, Tuesday 17 September from these transients. Earth may also already be encountering one of the forecast coronal holes and this has probably now peaked. A second coronal hole fast wind from CH70/+ may arrive day 2 or 3 (18 or 19 Sep), with Slightly Elevated to Elevated speeds possible.

G1-G2 is Likely in the coming 24-hour period from the CME(s). A lull should ensue around 24 hours hence before the fast wind from CH70/+ perhaps succeeds this later Wednesday 18 or perhaps early Thursday 19 September, giving a Slight Chance of further G1 intervals. The small stature of this coronal hole should mean that this activity is short-lived, with Quiet geomagnetic activity perhaps rounding out the four-day period.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is slightly elevated following the X4.5 flare on 14 September, but remains below the S1/Minor Storm threshold with a peak in the past 24 hours of 4pfu. There is still a Chance that S1 proton storm levels may be reached day 1, however this risk should relax after midweek UTC to the resting value for the current disc (around 10% per day).

High energy electron flux should now show imminent suppression followed by rebound as a result of the arrived CME(s), but all within Slight Chance of Active 24-hour fluence. CH70/+ not felt likely to be impactful.

Figure 1. Solar Analysis Valid 16/1700UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME arrived at L1 at 16/2250UTC. This front may comprise up to two CMEs, but more likely the latter if made up of just one event. The first candidate is a CME from 13/0930UTC from an M2.9 flare from AR3814. The second and more likely candidate is the X4.5-related CME from AR3825 at 14/1528UTC. ACE EPAM LEMS showed a very slight rise prior to this arrival, however the lead time was very short (tens of minutes).

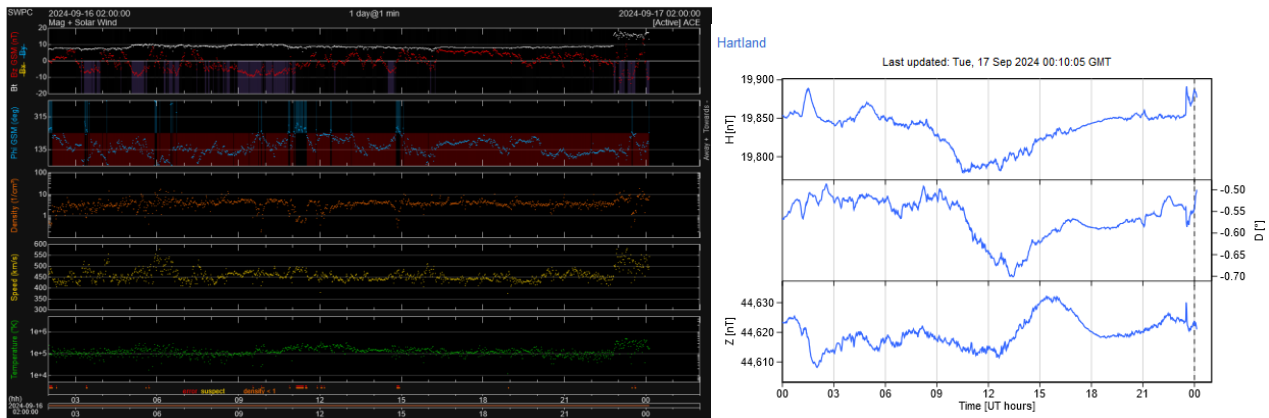
The fast wind forecast is probably of lesser consequence. A positive fast wind is perhaps now considered to already be in evidence and CH69/+ may have already arrived (perhaps on Saturday 14 September in hindsight). Given that this feature has probably peaked, a second small positive coronal hole near centre disc (CH70/+) may bring further Slightly Elevated to Elevated wind speeds at Earth for a time later on Wednesday 18 and into Thursday 19 September, prolonging a Slight Chance of G1 before waning to leave Quiet conditions before the UTC weekend.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	75	20	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: NOAA SPWC visualisation of the solar wind at L1 according to ACE, showing a CME arrival at 16/2250UTC. Right is a visualisation of BGS Hartland magnetometer data, with the CME shock visible as a 35nT change in Hartland H-component in the three minutes from 16/2329UTC



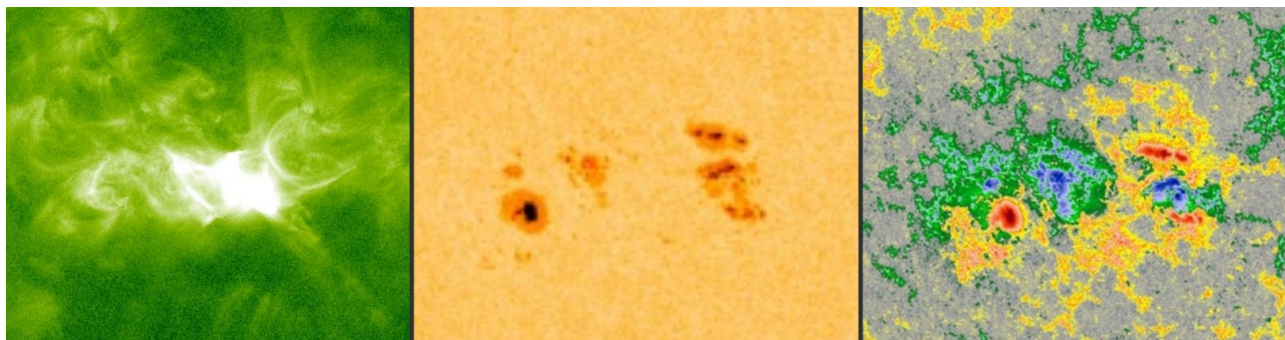
Radio Blackouts - X-Ray Flares:

The daily risk of significant flares is currently dominated by the pairing of AR3824 and especially AR3825 on the Earth-facing disc. The latter has a recent history of X-class activity, with this level perhaps able to be attained due to the long recharge times between flares. AR3824 is nominally the same Zurich class as AR3825, and although more open and areally much smaller it has a weak candidate for a Mt Wilson delta spot in its trailer that warrants monitoring.

Both of these dominant regions remain on the disc for almost the entire four days, with AR3824 reaching the limb by the end of the UTC working week. No significant regions are expected over the eastern solar horizon in the same interval, and the daily risk of flares is therefore held constant throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: AIA094, HMIIF and HMIBC of the peak flare of the period from AR3825 at 16/2356UTC.



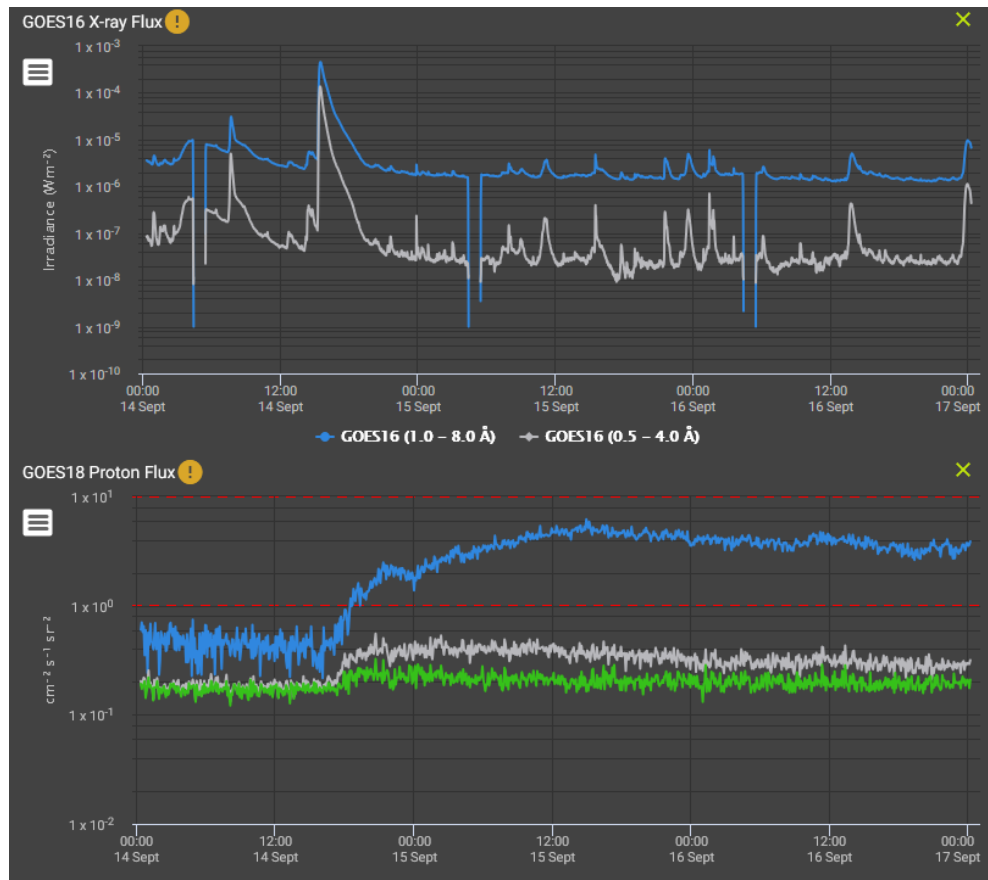
Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES18 has been above resting background levels since the X4.5 flare from AR3825 on 14 September, and has only shown a very gradual decline in the past 24 hours. There is a chance of new enhancements adding to levels currently seen. This would be more likely from AR3824 given its more favourable position in the western solar hemisphere, however AR3825 has already proved capable of enhancements from the eastern solar hemisphere and cannot be ruled out as a source.

All considered, there is a Chance of S1, peaking on day one, Tuesday 17 September and waning towards the background risk for the current array of sunspot regions after midweek UTC, by which time the current slight enhancement ought to have waned and any inbound CMEs ought to have passed 1AU.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	25	15	10	10
Very Active	≥ S3*	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

Figure 4: Three day visualisation of GOES16 X-ray flux and resultant GOES18 high energy proton flux, showing the ongoing response to the X4.5 flare.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux is currently showing a relatively flat diurnal oscillation peaking at High. The CME(s) expected have now arrived, and as such flux levels at GEO should show a period of apparent suppression before a possible rebound later in the coming UTC working week. The fast wind from CH70/+ is not felt likely to offer a significant driver to counts.

The forecast is therefore uncertain but should now show a suppression and then rise to a stable elevated level. This is represented by variations on a Slight Chance throughout. MOSWOC REFM is not considered to be useful in this instance given the dominance of a CME in the forecast outcome.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	5	10	20	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1